**LMG 14-01: 31 Dec. 2013 – 05 February 2013 LTER Cruise 22**
**Weekly Science Report II**
**Palmer Long Term Ecological Research Project: Looking Back in Time Through Ecological Space.**

**Cruise Overview (O. Schofield, Chief Scientist):**

The overall long term objective of Palmer LTER is to understand the mechanistic linkages by which climate, physical oceanographic forcing and sea ice extent and duration control ocean productivity, food web processes, krill and penguin recruitment and carbon biogeochemistry in the marginal sea ice zone of the western Antarctic Peninsula (WAP) region. The WAP is one of the most rapidly-warming regions on the planet, and we have documented responses throughout the foodweb from phytoplankton to penguins. The annual oceanographic cruise (now in our 22st year) provides a large scale regional view of physical trophic biogeochemical processes in the region, and contributes to a time series of ecosystem transformation in response to regional warming and sea ice loss.

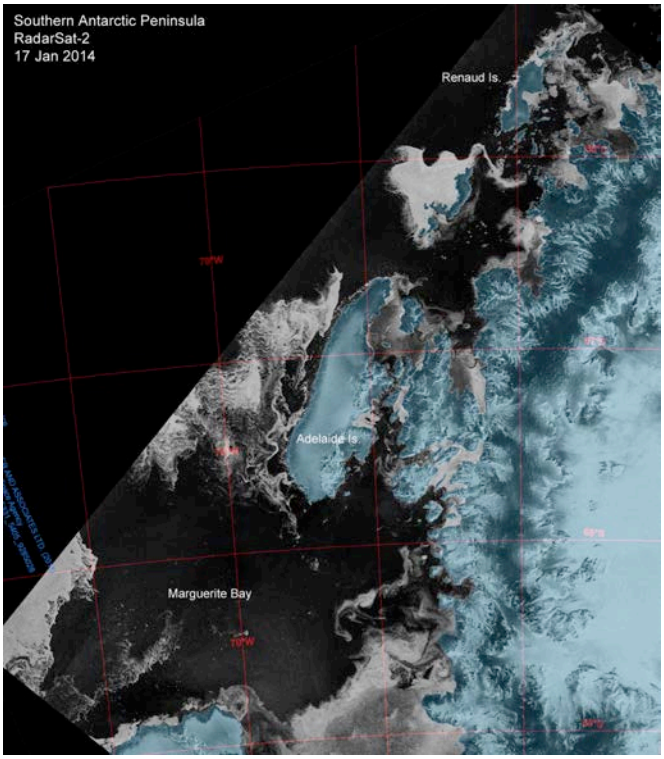


*Figure 1. Ice image taken January 19, 2014. The image shows significant ice in the mid-shelf and in the southern expanses of our grid.*

This cruise is about equally divided between 1) occupying standard LTER stations along the regional grid extending from Palmer Station to Charcot Island and from the inshore coastal region to deep (>3000 m) water off the continental shelf break in the Antarctic Circumpolar Current (Figure 1), and 2) conducting three, 3 day mechanistic process studies along the Peninsula. This year's process studies are focused on the relationships among bathymetry (submarine canyons), physical oceanographic forcing of the phytoplankton populations, krill abundance and penguin and whale foraging.

Despite heavy ice still in the sampling grid and heavy weather off Avian Island we continue to make good progress down the LTER grid (Figure 1). The heavy ice has impacted operations in that it resulted in slower steam times as we move through the ice. To date we have completed the 600, 500, 400, and 300 survey stations. We are completing the 200 line tonight (1/19/2014). We have conducted a complementary

process station in Marguerite Bay just offshore Avian island. The process stations in these inshore stations included sampling offshore on the inner stations of the 200-survey line and series of nearshore coastal stations close to the penguin colonies. At those stations we conducted our full suite of standard measurements. We also conducted a full mocness day-night tow, and a full day night acoustic survey conducted with the Echosounder towfish. We had our annual visit where we cross calibrated the sensors between the RV Gould, the British Antarctic Survey and the Dutch Antarctic program as we occupied 4 CTD stations offshore Rothera. As always it was fantastic to share science information with our partners at Rothera that reported similarly large microbial productivity, a low number of whales, and heavy ice. This cross-calibration is a critical component to ensuring that scientists can use compare the LTER and Rothera time series. During the visit to Rothera, Drs. Ducklow and Schofield were also both interviewed by the BBC onboard the Gould and onshore at Rothera station, to be part of an upcoming NOVA special in the Fall of 2014. On the evening of 1/19/2014, the third and final LTER physical oceanography was recovered. The successful recovery of the three moorings, now has the science and Lockheed teams quickly working to refurbish sensors to begin redeploying moorings potentially next week. Finally despite the uncooperative weather for 36 hours (sustained winds over 60 knots), the Birder team was successfully deployed at Avian island for the annual census. Recovery of the Birder team will be conducted 1/20/2014 in the early afternoon.

As always we are so lucky by the amazing support provided by the ECO and ASC personnel. Their support is unparalleled in my experience of 20 years going to sea on US and international research vessels. Lindsey Loughry continues to do an excellent job as MPC. We also wish to specifically thank both Mike Coons and Tony Daoust who have been invaluable in repairing equipment that was having trouble. To date they have repaired/rebuilt the mocness nets, the absorption/attenuation meter, the beta-counter for the Thorium measurements and the PRR radiometer. The expertise for doing these repairs is rare onshore much less at sea.

**B-045: Microbial Biogeochemistry Component (H. Ducklow, Lamont Doherty Earth Observatory; PI).**

**Field Team Members: H. Ducklow, Jeff Bowman, James Collins, Scott Doney, Naomi Shelton.**

The objective of this component is to obtain a mechanistic understanding of the carbon cycle along the Western Antarctic Peninsula, and the roles of heterotrophic bacterioplankton in these geochemical transformations. We are also concerned with possible responses of the microbial foodweb and biogeochemical transformations to climate warming. Our routine measurements include heterotrophic and autotrophic microbial abundance by flow cytometry conducted on-site, bacterial production by leucine incorporation, as well as water column inventories of dissolved inorganic and organic carbon, particulate organic carbon and nitrogen and inorganic macronutrients. We are collecting samples for oxygen-18 analyses to determine sea ice and meteoric inputs to seawater, in collaboration with LTER colleague Dr Mike Meredith (BAS-UK) Finally, we deploy a time-series sediment trap to collect settling particles and determine the export flux from the upper ocean.

We are also studying new production and particle export by simultaneously measuring 15NO3 uptake and the 238U:234Th disequilibrium. 15NO3 uptake profiles (incubated for 24 hours in screened shipboard incubators) allow us to assess the proportion of phytoplankton production stimulated by allochthonous nutrients. 234Th measurements allow us to determine the export rate of 234Th on particles that have sunk out of the water column during the roughly one month period of time prior to our occupation of a station.

Over the past week we have completed the three regular grid stations on each of lines 600, 500, 400 and 300; and also conducted a process study and extended line sampling on the 200 line in Marguerite Bay. This enabled us to extend our observations of unprecedented high bacterial production rates all along the coast and inner shelf region of our study area (Figure X). The accompanying bacterial abundance levels are about twice as high as normal, whereas the bacterial production rates are about ten times higher, suggesting enhanced specific growth rates. Many of the highest rates we have measured are at discrete depths in cold (<0C) water. We assume that these greatly elevated rates are a response to the large phytoplankton bloom that we have also traced along the coast.

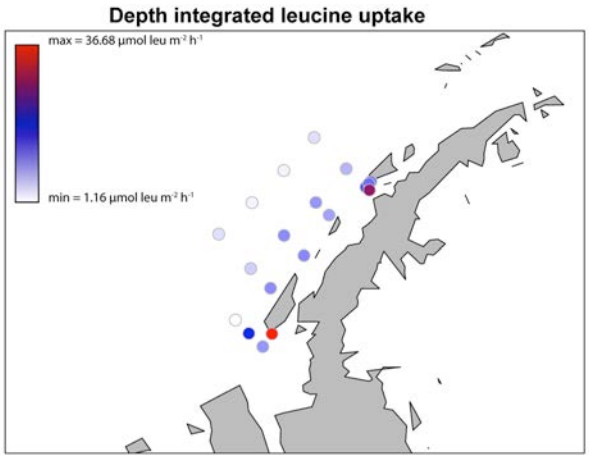


Figure 2. Spatial map of the leucine incorporation rates along the WAP during the first two weeks of the LTER cruise.

This year we're hosting PAL LTER Co-PI Scott Doney (WHOI), the leader of the mathematical modeling component in our project. Besides performing the Thorium-234 and New Production measurements in our project this year, Scott took time this past week to participate with the phytoplankton (019) and zooplankton (020) teams to become familiar with their sampling protocols and diversity of measurements performed by each group.

We thank all ECO and ASC personnel for the support. All of those down here with us serving in the trenches are absolutely awesome.

**B-019. Phytoplankton Component (O. Schofield, PI)**

**Field Team Members: Oscar Schofield, Filipa Carvalho, Nicole Couto, Oliver Ho, John Reinfelder.**

The objective of this component is to understand the biophysical forcing of the phytoplankton communities present along the West Antarctic Peninsula. We are also focusing on how climate mediated modifications in the community structure (both size and taxa) will impact the overall food web dynamics as well as altering the

biogeochemical cycling. Our routine measurements include bio-optical measurement (spectral radiometry as well as a full suite of inherent optical properties), chlorophyll a, HPLC accessory pigments, fluorescence induction and relaxation kinetics, and 14C-radiolabelled estimates of photosynthetic activity. Like the B-045 we found spectacularly high 14C productivities at the Palmer deep canyon. Overall phytoplankton and biomass declined offshore.

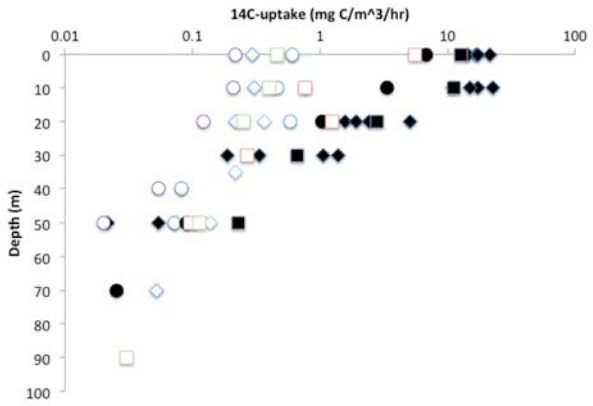


*Figure 3. The 14C incorporations measured during the LTER survey to date for the 14-01 cruise. The solid symbols are the inshore stations, with the open symbols representing mid-shelf and offshore stations. The different symbols represent the different LTER survey lines.*

The phytoplankton productivity rates have been exceptionally high. The high productivity is associated with a low salinity surface plume. The inshore stations have exhibited 14C incorporations that are often 2 orders of magnitude higher than the mid-shelf and offshore stations (Figure 3). These 14C incorporation rates are among the highest the LTER has recorded during the 22 years of field effort. The only mid-shelf station that had any comparable rates were associated with the large bands offshore ice. The blooms appear to be dominated by diatoms, however conformation will be available once the HPLC pigments measurements are completed. The first incubation time series experiment that was begun during the Process Station 1 in Palmer deep was completed. A second week-long incubation was started during Process Station 2 using coastal and canyon water collected offshore Avian Island.

**B-020. Zooplankton Component (D. Steinberg, PI)**

**Field Team Members: Joe Cope, Kate Ruck, Miram Gleiber, Jami Ivory, Domi Paxton, and Bruce Pfirrman.**

The overall objective of our component in the Palmer LTER program is to understand the role that zooplankton community structure plays in biogeochemical cycling of carbon and nutrients, and the effects of climate change on zooplankton communities along the continental shelf of the western Antarctic Peninsula. This year, with three process study stations, we emphasize the role that zooplankton play in the biological pump (grazing, particle or fecal pellet production, and diel vertical migration).

During the second week of the 2014 PalLTER field season, we completed full stations along the 400 and 300 grid lines and began the 200 grid line. We also conducted a number of tows and experiments during Process Study 2 off Avian Island, which included a number of 200 grid line stations. Samples were dominated by the krill *Euphausia*, especially the ice krill, *E. crystallorophias*. High numbers of larval

silverfish, *Pleuragramma antarcticum*, were noted in the Process Study region. After much trouble shooting by the ET personnel, the MOCNESS was functional for the second Process Study. A day/night pair of MOCNESS casts was deployed in the survey area. We were able to acoustically sample the outermost portion of the Process Study transect; high density of sea ice in the region prevented us from conducting a full bio-acoustic survey.

Fecal pellet production and dissolved organic matter (DOM) excretion experiments were conducted on the Antarctic krill, *Euphausia superba*. Fecal pellet production and gut evacuation experiments were conducted on the calanoid copepod species *Calanoides acutus*, *Calanus propinquus*, *Rhincalanus gigas*, and *Paraeuchaeta antarctica*.

We continued our collection for gut fluorescence, lipid, and biovolume-to-carbon ratio analyses for krill (*Euphausia superba*, *Euphausia crystallorophias*, and *Thysanoessa*), salps (*Salpa thompsoni*) and copepods (*Calanoides acutus*, *Calanus propinquus*, *Paraeuchaeta antarctica*, and *Metridia gerlachei*).

**B-021: Physical Oceanography Component (Doug Martinison, PI)**
**Field Team: Darren Mckee**

The objective of the physical oceanography group is understand the circulation and major transports of heat and salt in the WAP and how those transport processes affect the overall heat of the system. A major effort for this field season is to recover, refurbish, and then redeploy the mooring before the end of the cruise. We have successfully recovered all three moorings. We have been busy downloading the data, and preparing the sensors to be deployed again later in the cruise. We would like to thank the ECO bridge and the Lockheed ETs and MTs for great support during these recoveries.

**B-013: Seabird Component (W.R. Fraser, PI)**
**Field Team Members: Carrie McAtee and Brett Pickering**

The objective B-013's component of this year's LTER cruise (LMG 1401) is to continue the long-term data set of at-sea bird surveys to assess abundance and distribution across the LTER regional study grid. In addition, we plan to continue studies of Adélie penguin breeding and foraging ecology at Avian Island, which is located approximately 400 km south of Palmer Station. This southern study area located in Marguerite Bay provides a higher latitude comparison with seabird studies conducted at Palmer Station. If ice conditions allow we also plan to conduct similar fieldwork at Charcot Island.

The birder team was deployed on January 15$^{th}$ to Avian island where they are conducting full census, diet contents, and their comprehensive suite of measurements as part of the annual visit. The put in to Avian was delayed for one day due to both heavy winds and ice. Recovery of the team from Avian will be conducted on January 19$^{th}$ 2014. The ECO and ASC support during the put-in were spectacular.

**O-405: Physiological and Ecosystem Structure Forcings on Carbon Fluxes in the Southern Ocean Mixed Layer (Nicolas Cassar, Duke Univ., PI)**
**Field Team Operator: Yajuan Lin**

We are using equilibrator inlet mass spectrometry (EIMS) to measure net community

production (NCP) with high resolution. The instrument has been continuously measuring gases dissolved in seawater from the ship's underway system since December 31st. I am measuring Nitrogen (both masses 28 and 29), Oxygen, Argon, and Carbon Dioxide (masses 44 and 45). Measurements of O2/Ar supersaturation of surface waters will be used to constrain net community production (NCP) in the mixed layer. At steady-state, NCP is equal to new production and carbon export from the mixed-layer. We are interested in assessing the biogeochemical forcings on NCP and carbon export fluxes. The instrument hardware has been operating well.

**LTER Guest Component: Distribution, abundance, and movement patterns of baleen whales within the Palmer LTER study area (David W. Johnston, PI).**
**Field Team Members: Ari Friedlaender and Heather Foley**

Despite a substantial amount of survey effort with generally very good sighting conditions (521 nm), few marine mammals were sighted in the past week. Much of this likely has to do with the area in which we were working, Margeurite Bay. My initial belief is that with an intense phytoplankton bloom in the Bransfield/Gerlache Strait area leading to high abundance of food for krill and the relatively late retreat of the copious sea ice cover from the previous winter, that humpback whales simply remain well north of this area. Animals returning from their breeding grounds in western Central America would likely encounter significant amounts of krill farther north than in previous years and may have no need to continue farther south to where we are currently working. I also believe that in time the abundance of whales will increase and krill will become available around Margeurite Bay and that the whales will return to feed in high numbers. In the coming week we will likely move farther north and encounter more whales in the nearshore waters. We will collect biopsy samples for a number of these whales both the test for stable isotope signatures to determine what they are feeding on but also to discern the breeding stock of whales that are inhabiting these areas, the sex ratios of the population at this time of year, and add to our burgeoning demographic database of humpback whales.

The vast majority of our sightings, specifically of crabeater seals, occurred in offshore areas as we were transiting through large bands of pack ice that was located on the continental shelf. Aggregations of humpback whales were also seen on two separate occasions offshore from the pack ice. In both cases, ~10-20 humpback whales were seen within 3 miles of each other feeding at or near the surface.

*Figure 4. Humpback whale flukes off Anvers Island, Western Antarctic Peninsula.*

| **Species** | **Sightings** | **# of Animals** |
|---|---|---|
| Crabeater Seal | 155 | 485 |
| Leopard Seal | 5 | 5 |
| Antarctic Minke Whale | 10 | 10 |
| Fin Whale | 5 | 7 |
| Humpback Whale | 116 | 233 |
| Killer Whale | 4 | 21 |
| Weddell Seal | 3 | 3 |
| **TOTAL** | **298** | **764** |

Table 1. Updated sightings totals through week 2.